11 The Atlas of Canada – User Centred Development

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11.1 An Evolution in Mapping

The Atlas of Canada (http://atlas.gc.ca) was first published in 1906 and will celebrate 100 years of cartographic excellence in 2006. Through five printed, and now a complete Internet-based version, the Atlas has always shown a diverse geographical picture of Canada over its formative 20th and 21st century years of growth. The Atlas' role today is to present topical and issue-based information in a geographical context, through maps. It provides a home for national thematic and framework datasets. The Atlas team works with partners, in government and academia, to visualize data related to the Canadian society, economy, environment and history. The goal of the Atlas is to reach all Canadians as well as others interested in Canada, around the World.

Since the 1st Edition, the characteristics of Canada, as reflected in the Atlas, have evolved. The thematic focus, while diverse, began with an emphasis on transportation and immigration (1st and 2nd Editions), changing to industrial and urban development mid-century (3rd and 4th Editions) and then to the environmental and socio-economic themes and issues (5th and 6th Editions). The need for geographic information and knowledge has increased over the last 100 years and each published edition has reflected the information needs of the time (http://atlas.gc.ca/site/english/about_us/).

The advent of the Internet in the early 1990s offered a new direction for the Atlas of Canada and its first Web-based Atlas product was put on-line in 1994. The National Atlas on the Internet heralded the new influence of technology on mapping and cartography. This was a totally new mapping environment for both the Atlas and the user with new paradigms being developed with no pre-existing models and experience to follow. The Atlas experienced an incredible surge in the number of Canadians using its maps

in a way that would never have been possible with the previous printed editions. All these new users brought with them a new level of interest, expectation and demand on the Atlas. The efficiency of freely available maps available to anyone with Internet access changed forever the Atlas of Canada.

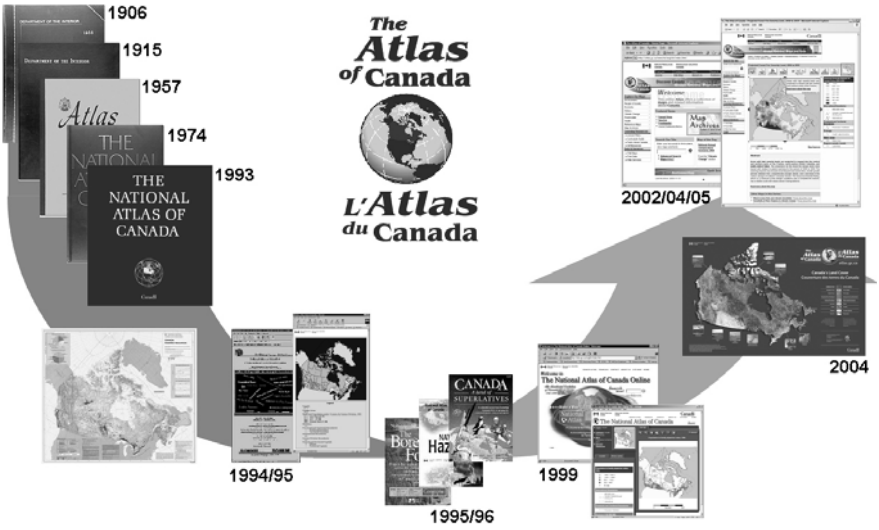

Fig. 1. The evolution of the Atlas of Canada, 1906 to 2005, Copyright, Her Majesty The Queen in Right of Canada.

The printed editions were published with little consultation and feedback from users. It was an era when government map makers were the "official purveyors" of cartographic products and while using established techniques and conventions, users were not included in the mapping and development process. The first Internet-based Atlas product moved quickly into the educational realm in a partnership with a new government initiative called SchoolNet (http://www.schoolnet.ca). The program encouraged the creation of quality educational resources in the new and emerging Internet. This introduced some consultation with the educational community through a Teacher Advisory Group. While technology and a "we know best" attitude still lead the way at this point, the teachers' influence was felt and the product development incorporated some of their suggestions. As a result the first positive effects from user input found its way into the Atlas.

The considerable success with the National Atlas on SchoolNet lead the way to a new Internet-based National Atlas program and includes the Government of Canada's commitment to on-line product and service transfor-

mation. This resulted in the official 6th Edition of the Atlas of Canada launched in Ottawa in August 1999. The latest mapping technologies were developed with a renewed focus on mapping content and other geographical information. The Teacher Advisory Group gave recommendations on content and organization of themes into issues. While this shift in direction was positive, the development of product was still left to an internal development team with very little input from the user. There was no formal process of including user groups in the development and design process. In addition, a very broad brush stroke was given to defining user groups, making them very large and inclusive. The Atlas wanted to be many things to many people, from basic to the more sophisticated users.

Despite these issues, the user base was growing and the success of the product was evident in e-mail feedback being offered through the Web site. Many of the early changes to the 6th Edition were based on these comments, but it was clear that not all issues were adequately dealt with in this way. The question of how representative the feedback was, along with not knowing how to continue to improve, led the Atlas team to realize it was time to better understand users' needs. This prompted many questions such as, who exactly are the users; what do they really use the Atlas for; how do they use it and how satisfied are they. The era of a user centred development and design process began (Williams, O'Brien, and Kramers 2003). In 2000-2001, comprehensive public opinion and usability research was conducted on the Atlas Web site, encompassing both design and functionality. The high-level objectives were to:

1. Identify and profile the Atlas of Canada's user groups;
2. Measure overall satisfaction with the site, focusing on the interactive and static mapping;
3. Assess the content, functionality, structure and usability of the site;
4. Understand users' behaviour when interacting with the site;
5. Determine the users' unmet needs with the existing site.

11.2 User Centred Development and Design

The User Centred Design process (UCD) adopted by the Atlas consists of three main stages prior to deploying additions or revisions to the Web site. The first stage is an examination of business requirements, followed by detailed user requirements research in the second stage. Next, in the third, is the product and systems design. This approach saves effort and cost due to the quality of the end result and the reduction of design errors (Nielson 1994). This process can be applied to any product or service. The Atlas

has used UCD for Web-based, data and printed products, and development activities such as requirements gathering, prototyping and product validation.

The process of defining business requirements begins with user and client definition (Scanlon and Percival 2002). It is impossible to be everything to everyone. Lack of focus or an inaccurate understanding of actual user groups results in a product that may end up not serving anyone's needs.

The business requirements stage is a high level look at the business case from the perspective of the organization, the user and stakeholders. The business needs and goals have to be assessed in conjunction with user acceptance of the product, addition or change. Is there sufficient requirement from both to proceed? Stakeholders, for example other government departments and academia, have a significant role to play in the Atlas with their sources of data and domain expertise. Do any goals for each group conflict? There are a number of research methods that allow the Atlas to answer these questions including focus groups, online surveys and structured interviews. The result of this research provides the general information and opinions that will support a business case and a decision to proceed with more detailed research. The feedback at this level is opinion based. It provides apparent clarity but it is not necessarily definite, factual or explicit. There is still a high level of assumption and proceeding into a design phase at this point would be risky due to the lack of specific user understanding.

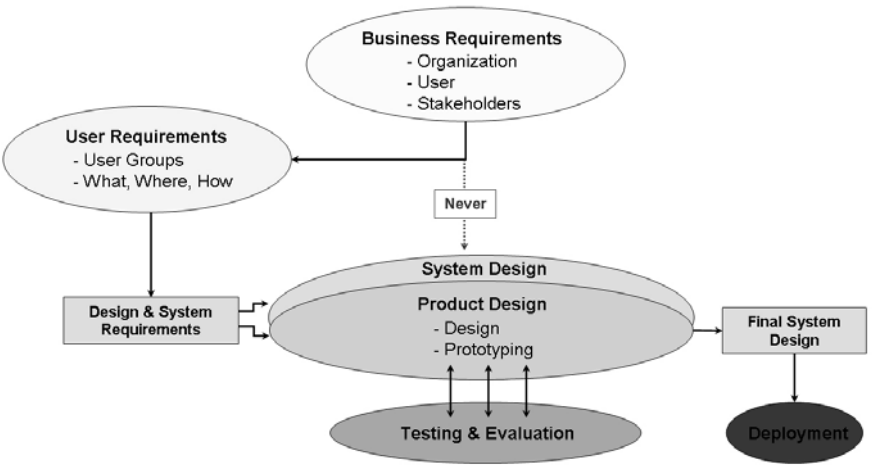

Fig. 2. The user centred design methodology.

The second stage is user requirements. At this point a more in-depth look at the composition, characteristics and needs of user groups is undertaken. This type of research allows an understanding of the difference between what users think they want and what they really need. Typical tasks carried out by individual user groups are identified. The goal is to find the actual need and then add functions to support that need. The contextual use is also important, and is different from the actual interaction with the on-line Atlas. It identifies where the Atlas is used and the factors surrounding that location of use.

The Atlas has collected user requirements information using on-line surveys, in-depth interviews and focus groups. Three on-line surveys were completed in 2000, 2003 and 2004/5. After defining the user groups and developing an initial user profile and satisfaction measurements, with the first survey, repeat surveys have provided insight into how they have changed over time. These are mainly quantitative in nature and provide valuable, statistically representative data. After conducting the surveys more qualitative research is done in the form of in-depth interviews. These interviews follow a consistent series of questions and can provide a much greater understanding of specific user needs, uses and satisfaction with the Atlas. They can also probe into issues discovered in the survey providing the clarity necessary to fully understand them.

A simple example from the most recent on-line survey completed in January 2005 illustrates the information and insight to be gained. Educational users were identified in the business requirements stage as a primary user group with strong current use and excellent potential for growth. A more specific breakdown of this group, in the user requirements research, revealed this group's composition.

The table below shows the percentage distribution of the various subgroups.

Table 1 "Educational Subgroup" data is from the Atlas of Canada On-line Survey Report, March 2005, Copyright, Her Majesty The Queen in Right of Canada.

Educational Subgroups	Percentage
Total Student (elementary, secondary, university)	21
Elementary Students	2
Secondary Students	6
College/University Students	13
Total Teacher (elementary, secondary, university)	9
Elementary/Secondary Teacher	5
Professor	4
Other Education related	1

Another interesting characteristic is the actual use of the Atlas. The following table shows the various reasons visitors use the Atlas resources.

Table 2 "Use of Atlas" data is from the Atlas of Canada On-line Survey Report, March 2005, Copyright, Her Majesty The Queen in Right of Canada.

Use of Atlas Information	Percentage
Personal project or research	39
Own school assignment/project	14
Work assignment or report	17
Child's school assignment or project	5
Develop or support curriculum	10
Travel/trip planning	2
Immigration/ visit to Canada	2
General browsing	4
Share info with friends/clients/children	2
Other	2
Not Used	2

By correlating the user groups with the type of use, a clearer profile is created of individual user groups, as shown in the table below. This is only one attribute and can be done with more of the data collected.

Table 3 "Use of Atlas Information by User Group" data from the Atlas of Canada User Profile Summary Report, March 2005, Copyright, Her Majesty The Queen in Right of Canada.

Use of Atlas Information by User Group	Students	Teachers	Personal Users	Work Related Users	Users Browsing
Personal project or research	19%	15%	78%	12%	46%
Own school assigment	56%	11%	/	1%	4%
Work assignment or report	5%	7%	2%	64%	7%
Child's school assignment	1%	5%	3%	1%	6%
Develop or support curriculum	11%	54%	1%	13%	7%

An example of the value of the in-depth interviews is shown in the understanding of the context of use for a high school teacher. The results provide a profile as follows: a high school teacher typically uses the Atlas to find a drainage basins map, at home, in the evening, over 15 to 30 minutes with or without interruptions to find resources, printed on a colour printer, to support the following day's environmental studies lesson plan.

The outputs of this research are detailed user profiles and typical usage scenarios. A user profile would include detailed information in areas such as demographic characteristics, behaviours in site use and satisfaction and loyalty measures. A usage scenario begins with a description of why a typical user needs a product or service, their context of use, followed by all the tasks that would be carried out to fulfill that need. These are the source inputs for the product and systems design and bridge the user requirements and design stages. At this point use cases are developed, based on the usage scenarios, to support system design. A use case is a description of a sequence of events or interactions between a user and a system for a specific task. Design principals including standards, organizational guidelines, and technical requirements are all taken into account.

The third stage has two major components, the product design and the systems design, the "front end" and the "back end". Product design begins with simple concepts, paper mock-ups, and story boards. These are the first components that can be put before typical users in a usability test. The results of the testing allow design decisions to be made for improve-

ments and the development of more sophisticated and detailed prototypes. These can then be assessed. This process is repeated and the number of iterations or cycles depends on many factors including the complexity of the product, time and funds available. Ideally, iterations are repeated until an acceptable level of completeness is achieved. Usability testing does require some financial and human resource investment but the results speak for themselves and make it completely worthwhile (Souza 2001). Systems development occurs at the same time with points of interaction based on the usability testing schedule and the inputs required from it.

Usability tests assess a participant's response to and performance on predetermined testing scenarios that are based on the usage scenarios. The testing scenarios are a series of tasks linked together to form a complete sequence of steps that a typical user would conduct. They are based on the user profiles and usage scenarios determined in the user requirements stage. Success is measured by observation and the ability of the participant to complete the tasks. Participants go through the scenarios individually with a moderator who observes and records the results. The interviews can be observed by the project team, in another room, either through one-way glass or by video link. There are no other people involved in the session and no interruptions. Participants typically talk out loud to express what they are thinking as they carry out the tasks. The combination of this and the actual observation are invaluable in understanding whether something works, how well and what issues there may be in preventing a successful result. Different testing scenarios of the same function or interface design can help to refine them. If a task is unsuccessful, analysis of the participant's performance can lead to better design decisions. The results of a usability test are objective. Design is not achieved with a usability test; design decisions are made based on them. This environment is also not suitable for subjective, opinion based feedback. Questions and comments can, however, clarify a usability issue. It is commonly accepted that six to eight participants are sufficient in assessing usability (Nielson, 1994 and Szeredi and McLeod, 2000), but not to be representative for opinion based feedback.

The release of a product is not the end of the story. Continued feedback from a broad range of users is necessary in assessing overall success. Methods of collecting this include surveys (on-line, mail, phone), focus groups, interviews and even usability tests. The UCD process aids in removing risk that permits much greater levels of success. Table 4 shows a number of satisfaction measurements from the three surveys.

The UCD process, used in part and entirety, has been implemented by the Atlas for every change, revision and new component. In many cases research for one component of the Atlas, can be used for another. For example, the results of usability testing on the thematic mapping user inter-

face can be used in developing the Archive Mapping user interface. The result is that a single usability testing iteration was necessary to complete this new archive component. In another case when developing a new promotional poster-map series, user requirements research from the on-line Atlas and printed wall maps reduced the amount necessary for this project.

Table 4 "Satisfaction attribute" data is from the Atlas of Canada On-line Survey Reports, March 2001, March 2003 and March 2005.

Satisfaction Attribute	2004 Survey	2003 Survey	2000 Survey
Overall site satisfaction (satisfied or very satisfied)	81%	79%	63%
Overall satisfaction with interactive thematic maps (satisfied or very satisfied)	82%	71%	57%
The scope of information provided meeting needs	68%	64%	49%
Willingness to return	88%	75%	72%
Recommend the site to others	88%	79%	78%
Number of 1st time users	67%	78%	79%

11.3 The Value of the User Centred Design Process

The following lessons have been learned in implementing the user centred design process:

- Define the audience and mission;
- Organizational buy-in – spend the time selling the process internally to operational teams and management;
- Never assume anything about your users;
- Understand the UCD process – you cannot just talk to friends and colleagues and call it usability testing;
- Balance UCD needs with budget and time, strive for a functional/achievable solution; do as many iterations as time and money allow;
- Integrate it into the production process; it should not be optional;
- UCD saves money in the end;
- Remove everything that is not needed;
- Function is more important than aesthetics;
- Fast direct access to primary content is paramount;

- Have a clear hierarchy of content;
- Spend time, but not too much, on labels: you cannot please everyone. Don't assume users know what you mean – avoid jargon, select words users would understand; and
- Make the site usably dynamic.

The user-centred approach to Atlas' design and development has been invaluable. It has reduced the effect of inaccurate assumptions. Using the results of the various research methods has led to a greater level of informed decision making. The Atlas has broken away from the internal "we know what's best" cycle. In the past, assumptions were based on anecdotal comments from many sources that were inaccurate and not representative of Atlas users. UCD has provided a structured method of balancing business and user requirements. This process separates developers and development teams from evaluating their own designs and solutions therefore reducing internal bias. The net value and result is increased user satisfaction and product effectiveness by producing the right product, for the right reasons, for the right users.

11.4 Case Studies

Three case studies will be presented that illustrate the user-centred design process and the results that came from employing it. The first describes a number of general user interface design issues and the solutions that were applied to the Atlas. The second outlines the usability problems encountered with the early mapping user interface tools and how these were modified. The third describes how the user-centred design methodology was applied to the integration of topographic maps in the Atlas. This example describes why and how specific research methods were used and the type of information that was collected from each.

11.4.1 Case Study 1 – Mapping User Interface Design

The first Case Study illustrates how the Atlas' thematic mapping user interface was evaluated and redesigned using the User Centred Design (UCD) process (Miller and Pupedis 2002). The first mapping user interface design for the Sixth Edition (1999) came about as a result of the best efforts of the design team. It reflected their understanding of what would make a suitable and usable on-line mapping user interface. The arrangement of the mapping user interface components and the functions and tools all worked from their perspective. The UCD process brought to light the difference between what

the Atlas' development team thought to be the right solution and what users needed and found usable. Without the UCD process, this would not have been known. The two screen captures below show the Sixth Edition's original thematic mapping user interface (1999) on the left and the version that resulted from the UCD process (2002) on the right.

Fig. 3. The original (1999) and revised (2002) thematic mapping user interfaces.

The two images in figure 3 are shown correctly scaled relative to one another. The first significant difference is the overall size. Research, undertaken in 2000, revealed that 95% of Atlas users used a screen resolution of 1024 by 768 pixels or less or their monitors, with half of those using an 800 by 600 pixel screen resolution. In addition, Government of Canada Standard Web site "Common Look and Feel" specifications (http://www.tbs-sct.gc.ca/clf-nsi/) required that all pages use a format compatible with the 800 by 600 pixel format. What is visible, using that dimension, is shown with the red outline on the user interface images in figure 3. That meant that the components of the first user interface were not completely visible and required users to scroll continuously to view and use them.

A number of issues presented themselves as a result of the layout of the user interface components. In the upper left corner of the original UI there were a series of four links to other textual, graphic and multi-media resources related to a map's theme. They were placed in this prime location to attract attention. There were two significant issues with them. First, their titles did not mean anything to users and, second, when the map was viewed they were no longer visible in the browser window. This was remedied by replacing these links with a new tool in the tool bar.

To the right of these links is the locator map. This was given a prime location to provide easy and quick reference to the user when zoomed into the map. The research revealed that users did not use the locator map and it was only partially in view when the map was in full view. In the new user interface it was made slightly smaller and given a new location in the upper right corner that reflected is importance relative to other user interface components.

The legend on the left side, while detailed and clear, presented a number of problems. Firstly, it began at a position almost halfway down the map. Secondly, it used more screen real estate than was necessary. Thirdly, it was too detailed and spread out, therefore requiring the user to scroll vertically. Finally, when the map was viewed, almost none of it could be seen due to horizontal scrolling required to see the entire map. The user requirements research also found that users really only wanted information relevant to the maps theme in the legend, not all the base map features. The new legend design corrected all of these issues as can be seen in the image to the right.

On the original interface, just above the left side of the tool bar, is a small button that allowed users to go to the table of contents and select another map. While the button was the most clear and usable on the user interface, it did require users to go to another page and follow a rather long and cumbersome process of selecting a new map. This problem was corrected with placing menus on the left side of the window. This successful solution continues to permit access to every map in the Atlas, numbering over 1400 in late 2005.

The tool bar above the map had a number of significant issues that are described in detail in the next case study. The one point to mention here is that once users scrolled down to see the entire map, the tool bar was not visible. Once out of view it tended to be forgotten and not used. The result was that many users viewed the maps only at a very small scale without the benefit of all the tools that permitted their full detail to be explored. The new user interface design changed all of this making the tools visible whenever the map is viewed.

Adopting the UCD approach allowed the Atlas design team to understand the hierarchy and varying importance of the components of its mapping user interface. The map is always the most important followed by the tool bar, legend, locator map menus and other text and links. The new design corrected the previous issues with a new focus on the hierarchy and placement. That, in turn, resulted in greater user satisfaction and growth in the number of maps being fully accessed.

11.4.2 Case Study 2 – Mapping User Interface Tools

The second Case Study reviews the development of new tools for the thematic mapping user interface. The development for the Sixth Edition user interface (1999), as previously mentioned, was done internally and without user consultation. The tools were an assortment that the development team thought would sufficiently allow users to explore the interactive maps. They functioned like most "GIS-like" tools and the team expected that users would understand this behaviour. What was discovered was that users came to the mapping user interface with a different understanding of the tools. In many cases they had little previous on-line mapping experience to guide them. The result was that many users could not use the tools to effectively explore the maps. The two biggest oversights were first, not understanding what tools were needed by users and secondly, how the tools needed to function for them to be effective and useable.

The user requirements research uncovered what features or functions users needed and expected to be available with maps on the Atlas site. In order of priority the following functions were needed:

1. Zoom in and out;
2. Print a map;
3. View a legend;
4. Move about the map; and
5. Select a specific feature and obtain information about it.

While icons are a common and intuitive feature for identifying tools and their use, they did not prove to be the sole solution to designing effective and usable tools. The research revealed that all participants, regardless of user group, felt that a label should accompany an icon. Users also indicated that some form of explanation would be useful (for example, a mouse-over, tool tip or alt tag). Consequently, the mapping tool icons have a label as well as an instruction, where needed, for their use. Usability testing revealed that users responded best to a label beginning with a verb.

The image below shows the tool bar of the original mapping user interface from July 1999.

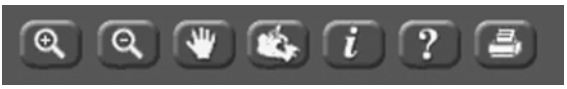

Fig. 4. The tool bar from the 1999 thematic mapping user interface.

The following image presents the new tool bar that resulted after the initial user requirements and usability research was completed in April 2002.

Fig. 5. The tool bar from the 2002 thematic mapping user interface.

Participants in the research intuitively clicked on the map to zoom in without making reference to the zoom tool and did not notice that it was highlighted indicating that it was the "active" tool. This was modified so that zoom in was active by default when a map appeared. The original "Zoom Out" tool worked in a standard two-step operation, one step to select the tool and a second to click on the map causing the zoom out action. Participants, however, expected it to work in a one step operation, invoking the zoom out action immediately upon clicking on the tool icon. The "Zoom Out" tool was changed to a one step operation so that when selected, the map would automatically zoom out one level, keeping the same map centre.

A zoom level indicator, that used five different sized circles, was not used by any of the participants in the testing sessions. Several printed mock-ups, using other shapes such as thin rectangles, were shown to those tested. Most indicated that the shape made no difference in their decision not to use it. This was surprising as this type of feature is commonly used by some well-known commercial Web mapping sites.

The "Pan" tool was not well understood. Participants did not know what the "hand" icon meant and as a result did not think of using it. Different icons were tested without success. The solution was to remove the tool, replacing it with eight panning arrows surrounding the map. This is a widely used solution and participants in the usability testing intuitively clicked the "arrows" to effectively "pan" the map.

When participants were required to move from one zoomed in location to another, they did not find or think of using the "Reset Map" tool. The icon used in the original interface was an image/icon of Canada. The confusion over a two step tool, as with zoom out, existed here as well and the participants required instruction on how it worked. When the "Reset Map" tool was described, participants felt it would be good to keep, even though they did not use it. Although they said this, their behaviour showed something else. They tended to want to zoom out and then zoom in, to move about the map. The "Reset Map" tool was removed from the tool bar and a "Zoom to Region" feature was added. It has a drop-down menu that includes Canada, the provinces and territories, and major cities. This was not tested, at the time, due to the available time and resources. It was suc-

cessfully used on other mapping UIs developed for the Atlas and in later usability tests it proved to be a valuable tool.

The "Query" or "Identify" tool, represented by an "**i**" symbol, was interpreted as a help symbol such as in a visitor information centre on a paper road map. As a result, participants did not think of using it to get information from the map. The two step process of selecting the tool and then selecting a feature on the maps also caused confusion. The "Query"/"Identify" tool, however, could not be converted to a single step tool. A clearer icon and label were needed, as well as, visible instructions to help users. The solution that brought some initial success was to create a new icon containing an arrow and renaming the tool "Get Statistics". There was limited success with this solution, but resources did not allow further research at the time. The tool was further improved, using a different icon, label and tool tip, with much greater levels of success in the most recent tool bar.

An important component of all interactive maps is their supporting textual, graphic and multi-media resources. These describe and illustrate the map's theme and interpret the patterns appearing on it. In the initial user interface (1999), there were links to these resources in the upper left corner of the UI. Most users did not easily find these as they were presented. In further research, it was found that users responded better to a tool with a book icon and a label, "Read Map Description" (2002). User requirements research found that these resources were valued. Due to their importance, more research was carried out developing a new information model, site structure and navigational tools. The "Read Map Description" tool was eventually removed and replaced with a small, removable, floating text box on the face of the map that contained a fact from the map and a link to the complete resources (2003).

Fortunately, the "Help" and "Print Map" tools were very intuitive and did not require any modifications except a graphic enhancement to fit with the other new tools. The "Print Map" tool was slightly modified after the usability testing of the Map Archives mapping user interface (2003). It revealed that the label "Print Preview" was more accurate as the tool invoked the page to refresh with a "printer friendly" formatted page that could then be printed.

Many more improvements, using the UCD approach, have been made to the tool bar since these changes. The following image shows the newest tool bar with improvement implemented in June 2005.

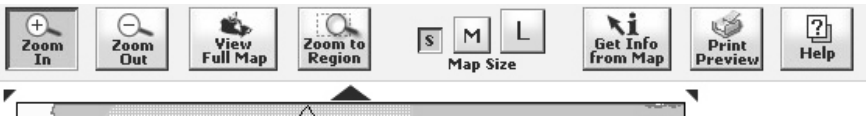

Fig. 6 The tool bar from the 2005 thematic mapping user interface.

The underlying lesson behind all the interface tools' issues and solutions is that a design team is not a user and cannot replace them. When designing the tools, as well as any product or service, those for whom the end product or service is intended must be part of the design process, from beginning to end. The perspective and experience of a development team is very different from that of a user and cannot replace them. That difference must be understood, respected and applied.

11.4.3 Case Study 3 – Integration of Topographic Maps in the Atlas of Canada

The third case study profiles how the User Centred Design (UCD) process was applied to bringing an entirely new component into the Atlas of Canada. This section focuses on the application of the process, rather than the actual results. The integration of topographic maps in the Atlas came about as a result of an internal review of the various Web mapping applications offered by the Earth Sciences Sector of the Department of Natural Resources. Management felt that the public would be better served if individual Web mapping applications, serving common user groups, were integrated or merged. The UCD expertise utilized in developing the Atlas site was beneficial to the further development of the existing on-line topographic mapping product, Toporama. The primary goal was to replace and update Toporama by successfully integrating topographic mapping data into the Atlas Web site while meeting the needs of both Toporama and Atlas users. The first step taken was to complete the examination of the business requirements.

An examination of the value of topographic maps to the Atlas and the opportunity this offered was done. The Atlas' maps were mostly compiled at a small scale of 1:7,500,000 with some at 1:1,000,000. Topographic maps are at the scales of 1:250,000 and 1:50,000. Feedback collected through user requirements and usability research, over many years, indicated that Atlas users did want maps at

larger scales. While topographic maps are not normally associated with a thematic Atlas, many Atlas users do in fact use them. More detailed information was required to fully understand who the topographic map users were, their needs and what the impact would be if both thematic and topographic maps were offered in the Atlas of Canada.

The first research step was to conduct an on-line survey of the existing users of the Toporama Web site to identify the user groups and their uses of topographic maps. This on-line survey would provide the remaining required information for the business requirements and the beginning of what was needed for the user requirements. The main objectives of the survey were to:

- Profile site users in terms of demographics and technology use;
- Understand users' motivations for using and returning to the site;
- Understand the manner in which the site was used;
- Understand most common usages of the topographic maps from the site;
- Measure overall satisfaction with the site and interest in current and future features; and
- Recruit participants for the in-depth interviews of the user requirements stage.

The results satisfied the business case and began the user requirements research. The on-line survey provided some initial high level insights but more specific and detailed information was needed. To achieve this, in-depth interviews were conducted with participants from each user group. The interviews were conducted in person and over the phone for out-of-town participants. The main areas of investigation for the user groups were:

- Characteristics typical of each user group;
- Characteristics of use – online interaction;
- Characteristics of use – offline interaction with topographic maps;
- Context of use – online requirements/Location Discovery;
- Context of use – output requirements; and
- An analysis of typical tasks performed by each user group.

The outputs of the user requirements research were detailed user profiles and usage scenarios. The profiles began with a description of a typical user. They established a persona around which typical characteristics could be identified. These included type of map use,

experience using maps, skill level, context of using topographic maps and goals in using maps and activities. The usage scenarios began with a description of how a typical user would use the map. It then listed the specific tasks that this user followed to carry out the complete scenario. For example, it began with finding the Atlas Web site, then locating a topographic map for an area of interest, outlining what user interface tools were used, how the map was interpreted and finally how the map was output or saved for off-line use. This was followed by a description of their context of use, both on and off-line.

Once the user profiles and usage scenarios were completed, they were used as primary input for the usability testing scenarios and the systems design use cases. There was a bit of initial skepticism among the project team as to the effectiveness of this approach. The personas seemed too personal and unrepresentative of the entire user group. The reason this approach worked was that the design decisions were made based on a real user carrying out a typical task, for an actual real-life use, not a fictitious user doing an imaginary task in a made-up situation. These usage scenarios, while focusing on a specific example, were based on the research that was representative of the broader users. Informed design decisions can be made very effectively this way. This approach worked extremely well with the design of the topographic mapping user interface.

The systems design proceeded with the completion the use cases describing the step-by-step operation of each function and mapping tool in the new user interface. The interface design was based on the Atlas' thematic mapping user interface. The new functions and tools required for topographic maps that were identified in the user requirements research were identified. For example, these included:

- new tools for determining coordinates;
- measuring distances and elevation;
- a new legend style;
- manipulating the map layers; and
- search tools for searching by coordinate, map sheet and place names.

In some cases, two or three variations, of the above, were designed for the usability testing. This allowed the Atlas team to determine what designs, labels and behaviour were the most usable.

The usability testing was done in three iterations using eight participants in each. The testing scenarios, based on the usage scenarios, were kept consistent through all three testing iterations. The first usability test began with the initial design and functionality assessment using static graphic models. In this step the variations for each tool and function design were assessed using different scenarios. Design and functionality decisions were made based on the results. This was followed, in the second testing iteration, by a more refined design of the user interface components and functionality. It was evaluated using graphic models with limited functionality. The final design decisions were made and a final prototype was produced. The use cases were updated and given to the systems design team. A final pre-deployment validation usability test is planned prior to deployment in the February 2006.

The image to the left below shows the final prototype of the topographic mapping user interface at the initial view, with the search tab to the right of the map. The image on the right shows a topographic map at a viewing scale of 1:50,000 and with the scrollable legend tab to the right of the map.

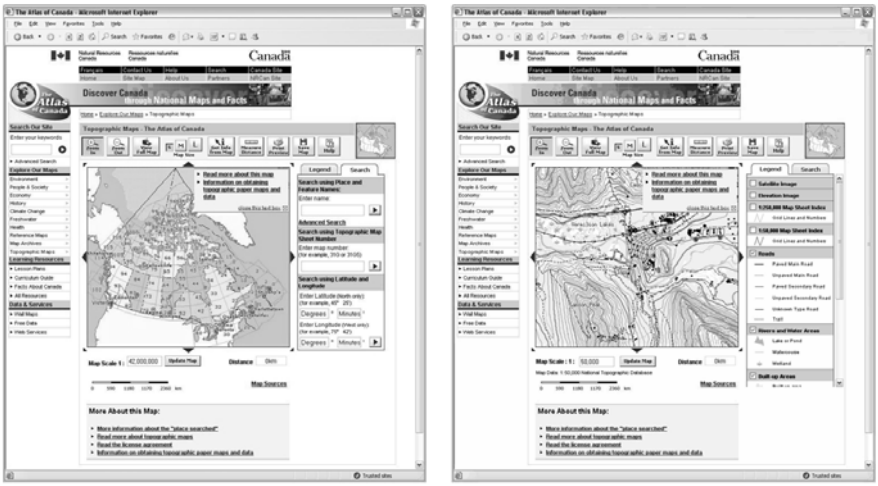

Fig. 7. The Atlas of Canada's topographic mapping user interface, 2006.

The integration of topographic mapping required the use of the entire UCD methodology. It allowed the Atlas of Canada team to understand and evaluate the user group(s), their needs for on-line to-

pographic maps and then make informed decisions on the product built for them. The design phase allowed for usability testing that determined what tools, behaviour and features worked best for the users. There are always many options that can lead to vastly different designs. Users bring their own knowledge, understanding and know-how and it is these that must be respected and understood for a truly useful product to be developed. The UCD methodology ensures that the resultant product incorporates the most correct and usable options. That, in turn, saves time and money and leads to success and user satisfaction.

11.5 Conclusion

The user-centred design process has fundamentally changed development in the Atlas of Canada. It, in fact, brought a change in mind-set from an internalized "we know best" approach to an outward looking and more open development process that includes the end user. Questions such as: Who are the users? What do they need? and How do they use it? are now central to the Atlas of Canada's design and development process. Possibilities not previously conceived of have been developed and utilized. It has resulted in the Atlas being the right product, for the right users, for the right reasons, at the right cost.

The UCD process does add a new set of tasks to the development time line and additional costs. While these cannot be ignored in accounting for resources, the end results cannot be ignored for their value. The first two case studies show the before and after of its implementation. The cost after the fact is much higher than if UCD would have been incorporated from the beginning. Products can be evaluated, improved and refined before they are deployed. From the point of view of the user, they want the best product from the very beginning, not after the mistakes have been made and corrected. UCD removes risk by ensuring that the decisions are made using the best information.

While using the entire UCD process ensures that the most usable and successful product or service is developed, it is not always necessary to be done in entirety. Time, personnel and financial resources do not always allow this. Which parts of the methodology are needed depends on what is being researched, changed or newly developed. The Atlas' business and user requirements research has been applied to many changed or new components. Research from the development of the thematic mapping

user interface has been used for others, such as the archive topographic mapping interfaces. What is important is that the relevant sections of the methodology be used as resources allow. When UCD becomes a part of the design and development process in this way, it always makes a positive difference to the end result.

The effect of informed decision making, based on research using valid and established methods, has allowed the Atlas to develop and grow with greater levels of success. This can be seen in increased and measurable user satisfaction as well as significant growth in overall use. The result has made the Atlas of Canada a more valuable resource for its users, an excellent outreach vehicle for the Government of Canada and a leader in effective geographic and cartographic communication.

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